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ORDNANCE
SCHOOL TEXT

ROCKETS AND LAUNCHERS ALL TYPES

FEBRUARY 1944

Prepared by

THE ORDNANCE SCHOOL
ABERDEEN PROVING GROUND, MARYLAND

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...poration of the information contained herein in an
approved War Department manual.

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ORDNANCE SCHOOL TEXT
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THE ORDNANCE SCHOOL
Aberdeen Proving Ground, February 1944

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ROCKETS AND LAUNCHERS,

ALL TYPES

Prepared under the direction of
the Commandant, The Ordnance School

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ROCKETS AND LAUNCHERS, ALL TYPES

CHAPTER 1—GENERAL

1 PURPOSE

This text is published for use in courses at The Ordnance School.

2 SCOPE

Chapter 1 covers material common to all rockets, such as the theory of flight, the history of rockets, and their advantages and disadvantages. Succeeding chapters are concerned with the various standard and development rockets, with a chapter assigned to each size of rocket.

3 REFERENCES

Information included in this text has been secured from the following publications:

a. Standard Nomenclature List S-9, Rockets, All Types, and Components.

b. Training Circular No. 104, Antitank Rocket, 2.36", M6 and M7, and Launcher, dated 15 December 1942.

c. Technical Manuals:
TM 9-390, Target Rocket Projector, M1; TM 9-393, 4.5-Inch Artillery Rocket Launcher, T35, and 4.5-Inch H.E. Rocket, M8; TM 9-395, 4.5" Rocket Materiel.

d. Minutes of the Ordnance Technical Committee.

4 HISTORY OF ROCKETS

a. The rocket has from early times attracted attention for military purposes, first in Asia and later in Europe and America. No great progress was made until the beginning of experiments by a William Congreve. Congreve extended the work of General Desaguliers, who was in charge of the famous Woolwich laboratory in England. Congreve set himself the task of producing a rocket capable of carrying an incendiary or explosive charge and having a range up to 2 miles. After some preliminary trials he was given permission to utilize the Royal Laboratory to construct rockets of his own design. The results obtained were so promising that in 1805 Sir Sydney Smith's expedition against Boulogne included boats especially fitted for salvo firing of rockets. Rough weather prevented their use on that occasion, but the following year they were used against the same place and, although deflected by a strong wind from the fortifications, which were their objective, they did considerable damage in the town itself.

b. In 1812 the Field Rocket Brigade was formed and was ordered to join the Allies before Leipzig. Captain Bogue of the Horse Artillery, the only English officer present, was made the commander. The effect of the rockets on this occasion — the first time they had ever been used in European

land warfare — was very marked. The Rocket Brigade also distinguished itself 3 years later at Waterloo.

c. During most of the 19th century, rockets carried an important share of artillery functions, although they did not come within measurable distance of superseding artillery, as Congreve in his enthusiasm had predicted. With the development of rifling, breechloading, independent recoil, and smokeless powder, the advantages claimed for rockets were discounted, and they were declared obsolete by the end of the century.

d. One of the first American proponents of rockets was Edwin Taylor, who, prior to and during the Spanish-American War, advocated the use of rockets to propel shells filled with dynamite and nitroglycerine. At that time these charges were too sensitive to withstand the high acceleration produced by a gun.

e. At the beginning of World War II, little interest was shown in rockets by the armed forces of this country. With the development of a successful antiaircraft rocket by the British, however, research was begun on a large scale. Work in the Ordnance Department on rockets as military projectiles using available modern propellants was begun on a small scale at Aberdeen Proving Ground, Maryland, by Col. L. A. Skinner in 1932. Much of the basic information which he secured has been of great assistance in the large-scale development which commenced in October 1942.

5 THEORY OF FLIGHT

a. Method of propulsion.— If, in a system of forces acting against each other, the forces are unbalanced (i.e., one of the forces is greater than the other), movement will proceed in the direction of the greater force. If gas is placed under pressure in a tube closed at one end, a system of unbalanced forces is set up which can result in movement of the tube. Figure 1 illustrates such an arrangement in its simplest aspect and indicates how a rocket secures propulsion. It will be noted that the pressure is applied in all directions (at the moment of maximum pressure of the gas). The arrows indicate the forces exercised by the pressure, and the length of each arrow indicates the magnitude of each force. The forces near the open end of the tube are smaller, because the gas has less pressure at that point. The forces acting on the walls of the tube cancel

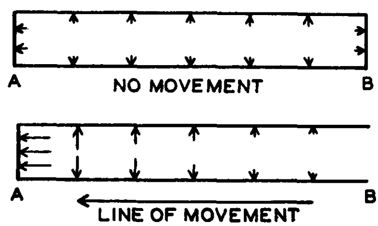

FIG. 1

each other, and the tube moves forward as a result of the force applied to the closed end of the tube. When the gas has escaped from the tube and the pressure outside the tube is the same as the pressure inside the tube, no force remains to move the tube forward.

b. Semiclosed end.— It is apparent that with the open-end tube the gas escapes rapidly, making a high pressure difficult to attain or maintain. By partially closing one end, a new situation occurs, as diagrammed in figure 2. (The pressure of the gas,

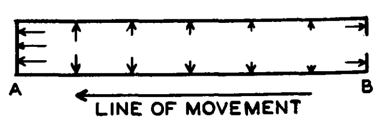

FIG. 2

acting as a force against the walls of the tube, is now, for the sake of explanation, everywhere equal). The forces acting against the walls cancel each other as before. In addition, the

forces acting against the semiclosed end B of the rocket cancel the forces acting against an equal area of the fully closed end A. Since the tube is partially closed, a greater pressure is achieved and the resulting force on the effective area of end A is greater than heretofore. The force acting against the end A may be measured in terms of the area of the aperture in the end B and the pressure of the gas. The smaller the aperture, the greater the pressure of the gas, but at the same time, the smaller the aperture, the greater the force applied to the effective area of the end A. A great many complications enter the theory of flight at this point, but, for the sake of a basic explanation, they will be ignored.

c. Introduction of the nozzle.— (1) Forward half.— By tapering the end

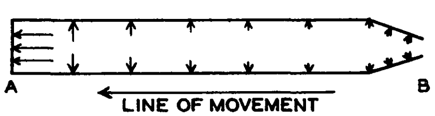

FIG. 3

B to the rear, the pressure of the gas is not changed, but a smooth, nonturbulent flow of escaping gas is created. This tapered section forms the forward half of the nozzle.

(2) Rear half.— If an extension which expands from the aperture is added to the nozzle, a system of forces which give a forward thrust to the tube is set up. Figure 4 illustrates how this is accomplished. There are prac-

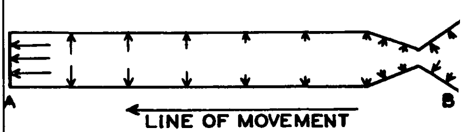

FIG. 4

tical limits to the length of this expansion as well as to the angle at which the expansion develops. In general, it may be said that the expanding part should be as long as possible in order to secure the maximum forward thrust and should diverge as rapidly as possible, but not so rapidly as to allow the flow of gas to leave the surface of the walls.

6 DESIGN

a. Terminology.— A rocket consists, in general, of several components. (See fig. 6.) The explosive head is the forward part of the complete round that contains the explosive charge. The motor is the tube that contains the propellant, which upon ignition produces the necessary gases. The fins are the attachments that stabilize the rocket in flight. The nozzle is the exit vent for the motor gases. The explosive head is usually placed at the front end of the rocket. The motor is attached to the base of the head. The nozzle is at the rear end of the motor, and the fins are attached externally at the same place. This terminology is not used to designate the component parts of any particular standard rocket but is reserved for discussions of rockets in general.

b. Explosive head.— Explosive heads for the various standard rockets differ considerably in shape but always have a streamlined appearance.

c. Motor.— The motor for all standard rockets is a tube. The walls of the tube have sufficient strength to withstand the anticipated pressures resulting from the burning of the propellant. A balance must be struck between the weight of the motor (the thickness of its walls) and the pressure that is to be achieved. A maximum pressure is desirable, but excessive motor weight will materially reduce the effective flight of the rocket.

d. Nozzle.— The development of the most efficient nozzle is still in process. At present the nozzle is a smooth piece in the form of a venturi. The forward curve is smooth and has a long radial distance. The rear por-

tion of the venturi develops at an angle of approximately 20°, the limit best suited to secure the maximum thrust.

e. Fins.— The fins vary in shape with the different rockets.

f. Propellant.— The development of a suitable propellant for rockets has been a difficult process. At present a propellant powder in stick form is used. This powder, which is ballistite, burns slowly and evenly, providing the maximum allowable pressure. The rate at which the powder burns (which is a determining factor of pressure) is determined by many factors. One of these is the diameter of the nozzle, which regulates the rate of escape of the gas. If the gas fails to escape at the proper rate, the pressure within the motor increases. As this internal pressure builds up, the rate of burning of the propellant will increase, further increasing the pressure until the wall strength of the motor is exceeded. The composition and the rate of burning of the propellant, then, affect not only the design of the nozzle but also the thickness of the motor. It may be seen that the balance to be achieved between the various components is a delicate one.

7 ADVANTAGES AND LIMITATIONS

a. Applications of rockets. (1) Rockets are of great importance because they produce no recoil. The lack of recoil permits their use on airplanes and small boats and on light tanks, cars, motorcycles and other vehicles incapable of withstanding large recoil forces. It also permits the firing if grenades and explosive charges from a tube held in the hands.

(2) Another feature of rockets that gives them military importance is the relative lightness of the projector in comparison with a gun firing ammunition of equal weight. This permits fire to be delivered from areas to which guns and howitzers cannot be transported.

(3) Lack of recoil is an important consideration, for it gives wide latitude in the selection of mounts and missiles. The mount may be of more delicate construction than is possible with a gun of equal caliber; missiles that cannot withstand gun acceleration can be projected rocket fashion. Absence of recoil has also permitted the development of sensitive and efficient fuzes.

(4) Of tremendous importance in considering the advantages of rockets are the ease and cheapness of manufacture of the launcher in comparison with the complexity and high cost of a gun. The rocket launcher is simply a guide and consists either of a tube or parallel tracks.

b. Advantages of rockets.— The advantages of rockets, then, may be summarized as follows:

(1) Absence of recoil.

(2) Accelerations that are not excessive and that are easily controlled.

(3) Need for only a light, inexpensive, easily mass-manufactured guide launcher.

c. Limitations of rockets.— The following disadvantages limit the application of rockets.

(1) The dangers resulting from the blast of the gases escaping through the nozzle.

(2) Decreased accuracy in comparison with a gun.

8 USES

At the present time there are five kinds of rockets. They are classified for use as follows:

a Antitank.— The antitank rocket is fired from the shoulder for effective action against armored vehicles and hard-surfaced materials.

b. Antiaircraft target rocket. This rocket is fired from a special launcher to simulate the flight of low-flying aircraft in order to provide anti-aircraft gun crews with a more accurate conception of combat firing.

c. Artillery and aircraft artillery.— This rocket is used in much the same manner as artillery in general and with the same mission. As aircraft artillery, it is fired from planes against other planes and from planes against ground targets.

d. Practice.— These rockets are fired to simulate the firing of high-explosive rockets, to which they correspond, without the danger or expense of firing the latter.

e. Chemical.— These rockets project smoke and other chemical agents.

9 ROCKETS

a. Listing.— The following rockets are issued to the service:*

(1) Rocket, H.E., AT, 2.36", M6A1.

(2) Rocket, practice, 2.36", M7A1.

(3) Rocket, target, A.A., 3.25", M2.

(4) Rocket, H.E., 4.5", M8 w/Fuze, P.D., M4.

(5) Rocket, practice, 4.5", M9 w/dummy fuze.

b. Characteristics.— All the above rockets are projected from launchers with either rails or a tube to serve as a guide. As the function of rockets vary, their design varies accordingly, but all have the motor, nozzle, and fins at the rear.

c. Painting.— The rockets having a high-explosive content are painted olive drab; those having inert heads are painted blue. Painting will be discussed in more detail in the section devoted to each particular rocket.

d. Packing.— Packing will be discussed in the sections devoted to each particular rocket.

e. General safety precautions. (1) A distinctive feature of rockets is the blast at the base of the launcher when the rocket is being projected. Personnel are warned to stay clear of the blast area, for this blast is highly destructive.

(2) All rockets should be stored at a temperature that does not exceed the temperature range specified for the rocket. No rounds should be left exposed to the direct rays of the sun for any length of time in order to avoid heating the powder to a temperature above that at which the rocket is designed to operate. Local conditions will govern the type of storage place that is supplied. The several temperature limits have been carefully determined for these rounds, and these limits should not be exceeded.

*The nomenclature of the rockets listed is correct and complete. However, in the interest of brevity it will be shortened throughout the following discussions. Modifications are occurring rapidly, and therefore the above list is subject to change.

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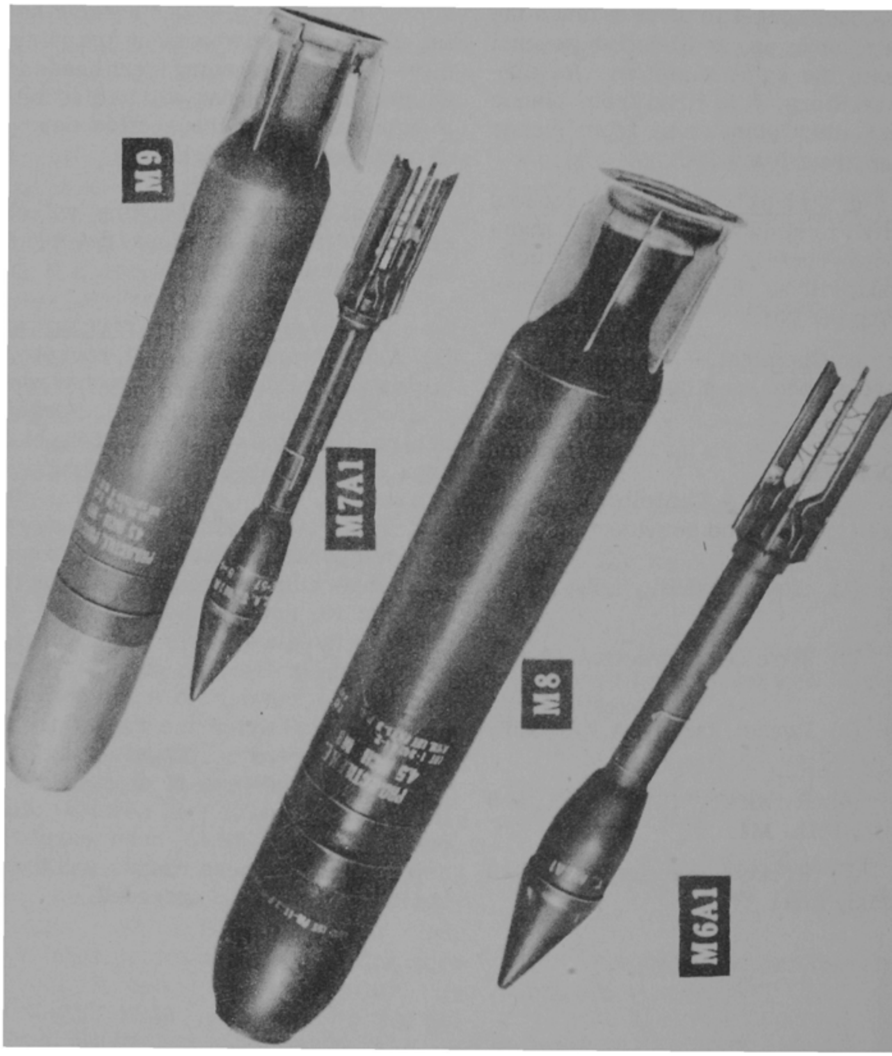

FIGURE 5. - ROCKETS CURRENTLY IN USE

CHAPTER 2—2.36" ROCKETS

SECTION I [redacted]

ROCKET, H.E., AT, 2.36", M6A1

10 GENERAL

a. Description.— The antitank rocket, 2.36", M6A1, is both an offensive and defensive weapon. In both types of action, it is used primarily to fire upon hostile armored vehicles which come within effective range. It is essentially a weapon of opportunity. It is 21.6" long and weighs 3.5 lb. It has a relatively low rate of fire and a distinctive flash discharge. Its muzzle velocity is approximately 265 ft./sec. The maximum range is 700 yd., but the rocket is comparatively inaccurate at ranges over 300 yd. In the hands of trained personnel, it is a powerful supporting weapon at short ranges with limited fields of fire. It is highly effective against all known types of medium tanks.

b. Tactical use.— (1) Offensive action.— Being both highly mobile and effective against pill-box and mechanized defenses, the antitank rocket, 2.36", M6A1, is a valuable weapon to be carried by landing forces, raiding groups, tank-hunting parties, and motorized reconnaissance units. It is capable of delivering harassing fire against an area target from ranges as great as 600 yd. and so is extremely valuable in attacks on vehicular bivouacs and halted or disabled armored vehicles and for use in ambushes.

(2) Defensive action.— The foremost use of this weapon is that of a defensive weapon against the attack of mechanized forces. It should always be conserved for this emergency purpose. Whenever time permits, rocket teams will be assigned a definite place in the antimechanized defense of a weapon, unit, or installation; and if natural cover is not available, two-man-type fox holes will be dug for each rocket team. In the event of a surprise attack, rocketeers must maneuver themselves in the most favorable position to direct their fire against the nearest hostile vehicle. The antitank rocket is valuable in the following defensive situations: the close-in defense of crew-served weapons; the protection of motorized columns on the march and at temporary halts; the protection of mine fields, wire entanglements, observation and command posts; and the defense of all rear-area installations of all arms and services within the range of hostile mechanized forces.

(3) Miscellaneous.— In addition to the above uses as an antitank projectile, this rocket can also be used in a stationary emplacement for demolition or as an antitank mine or a booby trap.

c. Effect.— (1) The rocket will penetrate 3" of homogeneous-steel armor plate at all ranges and at angles of impact as low as 30°. The force of the detonation is so great that the metal of the armor plate is raised to a state of incandescence and heated particles of the metal fly from the back of the plate in a cone-shaped spray. This spray has antipersonnel effect as far as 30 yd. and usually causes any ammunition which it strikes to detonate.

(2) Against masonry and structural steel, the rocket has a powerful blast and shattering effect. It will penetrate up to 9" of pine timber, but its continuing spray is not as effective as in the penetration of armor plate. Ground impact will not ordinarily cause detonation at high angles of impact. At low angles of impact, the blast effect is similar to that of the 75-mm high-explosive shell. Impact against water will never cause detonation.

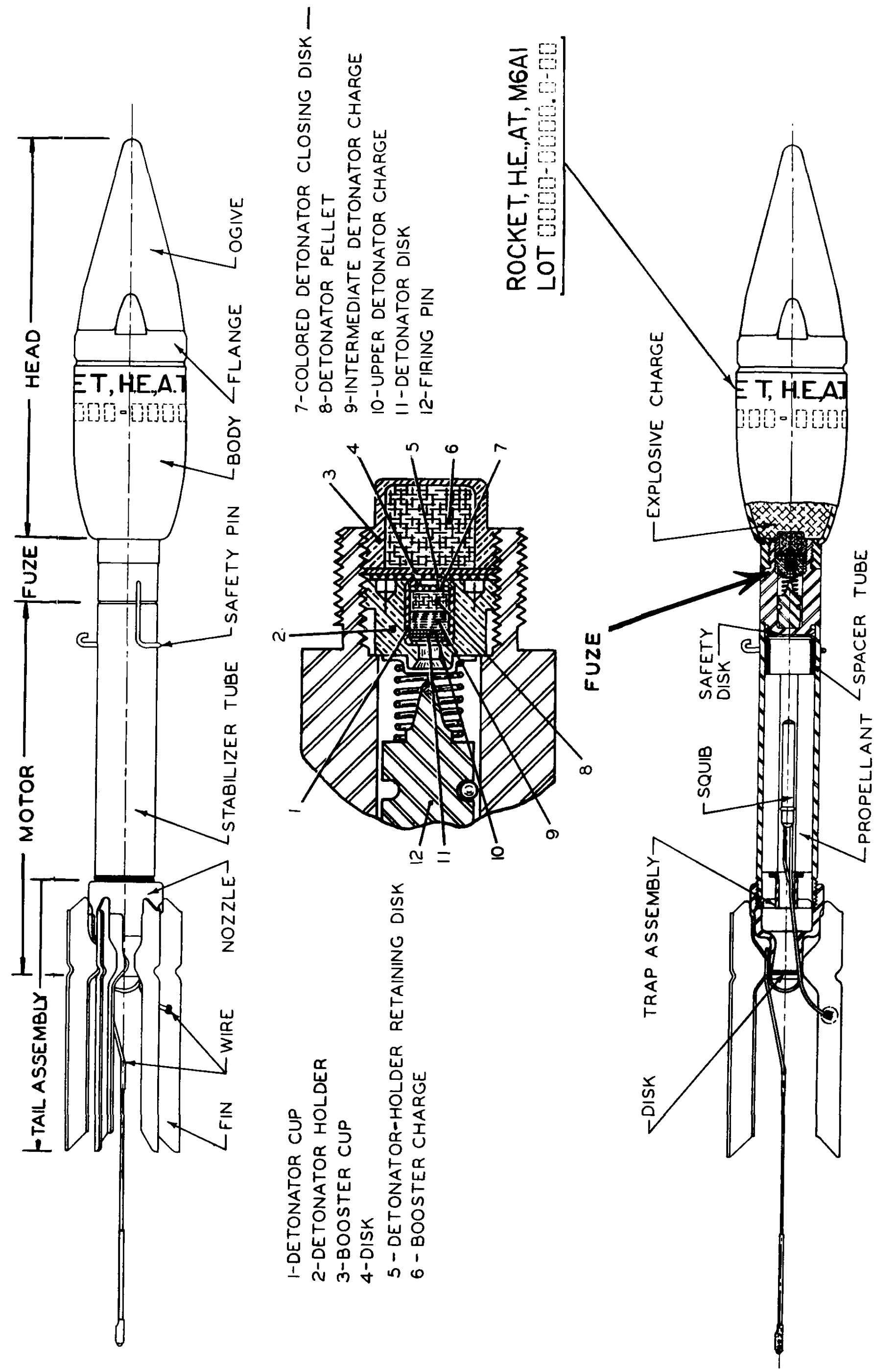

FIGURE 6. - ROCKET, H.E., AT, 2.36", M6A1

11 ROCKET LAUNCHER, M1A1

a. General.— The 2.36" antitank rocket launcher, M1A1, is an electrically operated weapon of the open-tube type. It is fired from the shoulder in the standing, kneeling, sitting, or prone positions. The tube has a smooth bore and is approximately 54.5" long. It is 2.37" in internal diameter and weighs 13.26 lb.

b. Description.— (1) Attached to the left side of the barrel are the front and rear sights. The rear sight is a peep sight; the front sight consists of three studs for ranges of 100, 200, and 300 yd. Intermediate or greater ranges, lead, and windage must be estimated by the firer.

(2) Ahead of the front sight and secured to the tube by a screw and nut is a flash deflector of conical wire screen with a mounting clamp which overlaps the muzzle end of the launcher. The flash deflector deflects particles of unburned powder which might fly back in the face of the firer.

(3) The hand grip consists of the left and right trigger grips attached to the trigger support. The trigger support accommodates the trigger guard, trigger, and the lower and upper trigger-switch contacts. The trigger is pinned at its upper end to the trigger support and is free to pivot.

(4) The stock has a narrow vertical slot by means of which it slips over the stock support, to which it is attached by screws. In the bottom of the stock there are two vertical cylindrical compartments for accommodating four batteries. The two batteries in the rear compartment are in actual use; the two batteries in the front compartment are spares. Eveready 791-A batteries are issued initially. When replacement is necessary, two separate cells of the battery BA-42 type can be used if the Eveready batteries are not available. The batteries are kept in position by a hasp assembly which fits on the bottom of the stock and is kept closed by a spring-actuated hasp catch which engages the stock pin.

(5) On the left side of the stock is a small electric lamp for testing the electric circuit and battery. The lamp is connected parallel with the firing mechanism, and it lights when the trigger is squeezed, regardless of whether the rocket is in the launcher or not. A spare lamp is carried in a circular compartment on the right side of the stock, under the circuit indicator cover.

(6) The face guard, pressed on the barrel above the stock and held in position by its own tension, protects the firer's face from the heat in the tube.

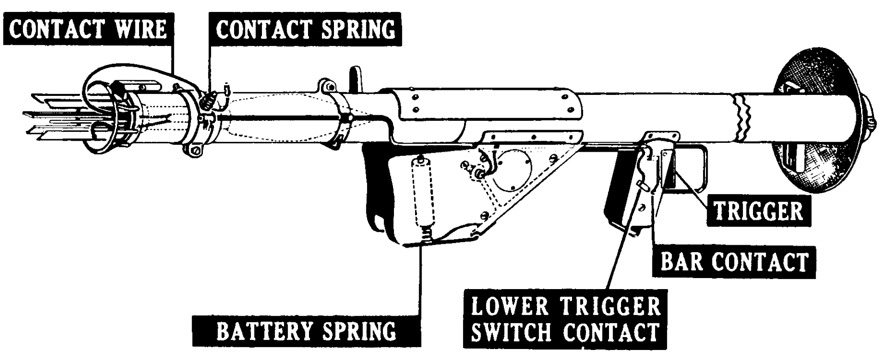

FIGURE 7. - ROCKET LAUNCHER, M1A1 [redacted]

(7) At the rear of the barrel is a spring-actuated tail-latch assembly. The function of the latch is to engage notches on the tail of the rocket and hold it in position for firing. The breech guard at the breech end of the barrel facilitates loading of the rocket, protects the tail-latch assembly, prevents distortion of the end of the barrel, and prevents entry of dirt and foreign material when the end of the launcher rests on the ground.

c. Electrical functioning (see fig. 7).— (1) When the trigger is squeezed, it presses the bar contact against the lower trigger-swtich contact to complete the electric circuit.

(2) The battery spring in the base of the stock contacts the batteries and is connected by wire to the stock support to complete the electric circuit. From the rear of the stock to the insulated contact springs, the barrel is wound with bracing wire. The two contact springs, one on each side of the tube, serve as connecting points for the contact wire leading from the rocket. In this manner, the circuit is completed. The electric current passes through the rocket and sets off an electric igniter which ignites the propelling charge.

(3) When the pressure on the trigger is released, the trigger spring forces the trigger to the forward position and the electric circuit is broken.

12 ROCKET COMPONENTS

The M6A1 rocket is 21.62" long and consists of a body and ogive assembly, complete with explosive components, and a stabilizer and fuze assembly, complete with explosive and propellant components. The total weight of the rocket is divided between these two component assemblies, the former weighing 1.57 lb., the latter, 1.82 lb. In the following paragraphs each component will be described. The explosive components will be discussed separately.

13 BODY AND OGIVE ASSEMBLY

This assembly (see fig. 6) comprises the head of the rocket. Taken by itself, it has the general appearance of a boattailed artillery projectile. It consists of a body, ogive, and body union.

a. Body.— This (see fig. 8) is a steel cup, 4.11" long, with a diameter of 2.23" at its forward open end and

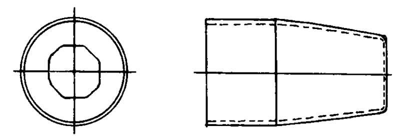

FIG. 8 -BODY

with walls 0.087" thick. The rear half of the body is slightly tapered, and in the rear face is punched a hexagonal hole, 1.06" across the flats. Into this hole is fitted the body union. An external longitudinal groove, 0.175" wide and 0.037" deep, is pressed 0.385" to the rear of the forward end of the body.

b. Ogive.— The ogive (see fig. 9) is a cone, 4-1/2" in height and 2.245" in diameter. The walls of the cone are 0.031" thick and are bulged out to form a flange approximately 1/2" wide at the base. This flange fits over the open end of the body and acts as the forward bearing surface of the rocket in its travel through the launcher. The flange is clinched securely into

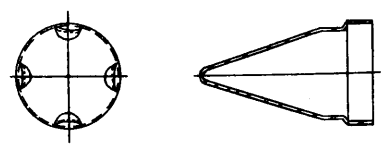

FIG. 9 -OGIVE

the groove in the forward outer surface of the body. Four depressions

are formed in the ogive just above the flange. These depressions rest on the upper rim of the body.

c. Body union.— The body union (see fig. 10) is a cylindrical component open at both ends. It is 0.78" in height and 1.25" in diameter. At the forward end, the body union is reduced to 1.058" in external diameter for a distance of 0.25" and is tapered internally. This allows the union to fit into the hexagonal hole in the rear of the body, where,

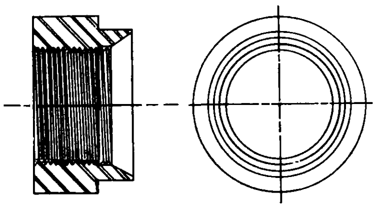

FIG. 10 - BODY UNION

after insertion, it is crimped into place. The central hole of the union is threaded to seat the stabilizer-tube assembly.

14 STABILIZER ASSEMBLY

a. Functions.— The stabilizer assembly has the following functions:

(1) To house the fuze and propellant. This part of the rocket is called the "motor," i.e., the part that does the propelling.

(2) To house the electric firing attachment.

(3) To serve as an escape vent for the propellant gases.

(4) To stabilize the rocket in its flight.

b. Components.— The stabilizer assembly consists of the stabilizer-tube assembly, fin assembly, electric wiring and connections, and trap assembly. The components are described in the following subparagraphs.

(1) Stabilizer-tube assembly. This component (see fig. 6) consists of a stabilizer tube, a fuze body, a safety pin, and a fuze.

(a) Stabilizer tube.— This component (see fig. 6) is made of steel tubing 6.322" long and 1.060" in internal diameter with walls 0.095" thick. The forward rim of the tube is chamfered; the rear 0.44" of the tube is externally threaded.

(b) Fuze body.— This component (see fig. 11) is a thick-walled cup, cut away on its forward part to form a

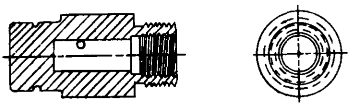

FIG. 11 - FUZE BODY

threaded projection 0.93" in diameter. The center section of the body is 1.25" in diameter; the rear section is 1.061" in diameter to allow a forced-fit joint in the forward end of the stabilizer tube. The over-all length is 2.317", and the central hole is 1.772" deep and 0.500" in diameter. At the point where the forward projection begins, the central hole widens to a diameter of 0.68". From this point forward, the central hole is internally threaded to seat fuze components. A hole 0.089" in diameter is drilled transversely through the fuze body just above the long axis of the body that intersects the central fuze body hole.

(c) Safety pin.— This component is inserted in the transverse hole mentioned in (b), above, where it restrains the firing pin of the fuze. Upon removal of the pin, the fuze is armed. When the safety pin is removed, DO NOT DROP THE ROCKET.

(d) Fuze.— 1 The fuze (see fig. 6) consists of a steel firing pin and a firing-pin spring. The firing pin is roughly cylindrical in shape and has a point 0.31" long protruding from the flat forward face. The firing pin slips into the central cavity of the fuze body, where it is held in a rearward position

by the firing-pin spring. A circumferential groove, 0.045" deep, midway down the length of the firing pin, receives the safety pin when the latter is in place. The safety pin, when in this groove, holds the firing pin securely in a rearward position. When the safety pin is removed, the firing pin is free to move forward, restrained only by the action of the firing-pin spring. Dropping the rocket as little as 4' will provide sufficient impact for the firing pin to overcome the tension of the spring and cause the rocket to be detonated. Therefore, when the safety pin is removed, it is necessary to take every precaution not to drop the rocket.

2 Below and in line with the firing pin and spring is the M18 detonator assembly and the explosive charge. The detonator assembly consists of an aluminum detonator cup, 0.342" deep, 0.190" in diameter, and crimped at both ends. It is housed in a brass detonator holder that screws into the internally threaded opening of the fuze body. A brass booster cup, 0.480" deep, 0.530" in diameter, and externally threaded on the rim, is screwed into place in the fuze body after the detonator holder is fitted. The booster cup and the detonator holder are separated by an onionskin disk and a detonator-holder retaining disk. The second disk is made of aluminum and seals, in turn, the detonator holder in place in the fuze body. The lower or unthreaded external half of the booster cup extends beyond the fuze body, and, when the stabilizer assembly is screwed into the rocket body, the booster cup fits into a recess in the explosive charge.

(2) Fin assembly.— The fin assembly, which guides the rocket in flight, (see fig. 12) consists of six steel fins and the nozzle. Each fin is attached to the nozzle by two spot welds on the lower flange.

(a) The fins are made of sheet steel 0.041" thick and 5-1/2" long. The fins are flanged at top and bottom in the shape shown in figure 12. In the upper edge of each fin is cut a notch 1-2/3"

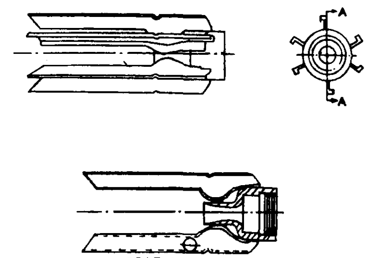

FIG. 12 - FIN ASSEMBLY

from the leading edge. This notch is kept free of paint and is tinned with solder. On the side surface of each fin, an area 1/8" in diameter is treated similarly. All external surfaces of the fin assembly except the tinned surfaces of the fins, which are kept free as electric contacts, are coated with olive-drab lacquer enamel.

(b) The nozzle is a steel cup internally threaded at the forward end. The rear face of the cup narrows and continues to the rear, forming the nozzle proper. The internal surface of the rear half of the nozzle is curved smoothly, as illustrated in figure 13, and is given a fine finish. The forward

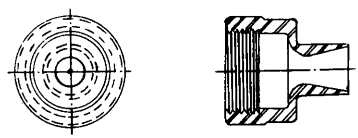

FIG. 13. - NOZZLE

half of the nozzle is 1.49" in diameter; the rear half is 0.687" in diameter. Internal surfaces of the nozzle are coated with a light coat of priming paint.

(3) Electric wiring and attachments.— This component ignites the propellant and is an electric squib with two insulated lead wires of unequal

length. The squib is thrust up into the stabilizer tube so that its forward end is approximately 5-1/2" forward of the rear end of the nozzle. Both lead wires, one 18-3/4" long, the other 6-3/4" long, extend rearward out of the nozzle. The short length is stripped sufficiently at its free end to allow it to be soldered to a tinned spot on one of the fins. The longer length of wire is wrapped twice about the under projection of one of the fins. The last 6-1/2" of the wire are laid bare, and a 1/2" length is folded back twice upon itself. Over this node of wire is wrapped a 6" length of 1/2" black tape. This taping facilitates grasping the end of the wire. The wire is then spiraled to take up its slack, and the free end is reversed and taped lightly (with cellulose tape) to the rear end of a fin (see fig. 6). When the rocket is loaded into the launcher, the wire is torn from the tape and its bared length engaged in the launcher clips.

(4) Trap assembly.— The trap assembly, which holds the propellant in the best burning position, consists of a steel trap body and a trap ring, shaped as illustrated in figure 14, the trap ring being staked to the trap body. The assembly is either cadmium or zinc plated.

(a) The trap body is made of steel and has eight equally spaced ribs.

(b) The trap ring is made of steel.

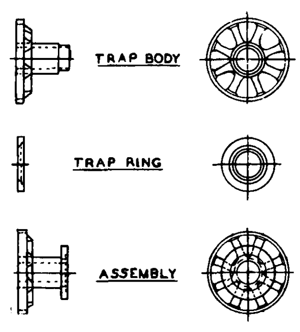

FIG. 14 TRAP ASSEMBLY

c. Assembly.— The fuze body is inserted in the forward end of the stabilizer tube and is held in place by the tight fit required. A silver-solder ring is slipped down the tube and, upon heating, melts and seals the internal joint between fuze body and tube. Following this, a dome-shaped disk is slipped down the tube, convex side up, and pressed flat against the fuze body. The disk is a safety factor; it removes the possibility of propellant flames or gases working through or around the fuze body to cause premature functioning of the rocket. The firing pin is inserted and the safety pin run through the transverse hole and the firing-pin groove. The detonator holder, with detonator, is screwed into the fuze body, followed by disks and the booster cup. The propellant is inserted in the tube. The trap assembly is screwed into the large opening of the nozzle, where it rests on the rim just below the internal threads. Then the fin assembly is screwed onto the rear threads of the stabilizer tube. Pettman cement is applied to the threads of the nozzle to waterproof the thread mesh. The rear end of the nozzle is closed with a chipboard disk, which is notched to provide for the passage of the lead wires.

15 EXPLOSIVE COMPONENTS

a. Propellant.— The propellant consists of five sticks of ballistite, each 0.36" in diameter and 4.15" long. The rocket is not loaded by weight but by length of powder stick — the purpose being to keep the pressure for various rounds at a relatively constant value. On the average, however, the propellant weighs approximately 61-1/2 grams. The propellant and its components are loaded as follows: A spacer tube, made of kraft paper, 1" in diameter and 3/4" long, is slipped into the stabilizer tube, coming to rest against the flattened disk. The five propellant sticks are slipped into the tube, coming to rest upon the rim of the spacer. When the

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nozzle is screwed onto the stabilizer tube, the propellant sticks rest on the rim of the trap ring and are held securely in place.

b. Other explosive components.— The body contains the explosive charge, and in the fuze body are the M18 detonator and the booster. The detonator consists of an upper detonator charge of 0.98 grains of lead azide and a detonator pellet of 1.26 grains of tetryl. The booster charge is a pellet of tetryl weighing 1.86 grains.

16 PAINTING AND MARKING

a. Painting.— All external surfaces of the complete rocket are coated with olive-drab ammunition paint. Those surfaces previously mentioned as being unpainted remain so.

b. Marking.— Just below the joint of ogive and body, the name of the round, the lot number, the manufacturer's initials, and the month and year of loading are marked circumferentially with yellow marking ink. All the letters and figures are 3/8" high. Sample marking:

ROCKET, H.E., A.T., M6A1

Lot 1234-56, P.A. 9-43

17 PACKING

The M6A1 rocket is packed one per individual fiber container, M87 (see fig. 15). Twenty such loaded containers are packed in a wooden packing box. The box, complete with contents, weighs approximately 136 lb. and is equipped with two rope handles to facilitate its handling.

a. Container, M87.— This container follows the standard design for fiber containers, consisting of a cylindrical tube and cover of laminated asphalt-filled chipboard. The container is 22-1/2" long and 2-3/4" in diameter. The tube and cover are each closed at one end with a terneplate end plate. A plywood support ring rests on a chipboard spacer at the lower end of the tube. It prevents the nose of the rocket from touching the end plate. After the round is inserted in the container, the cover is sealed in place by means of a strip of 2" adhesive tape 20-1/2" long. This strip is olive drab in color and has the designation of the rocket (Rocket, H.E., A.T., 2.36", M6A1) marked on it in yellow figures and letters.

b. Packing box.— (1) The packing box (see fig. 15) is 18-2/3" x 13-1/2" x 24-1/2" and is sturdily constructed of 3/4" lumber reinforced by end and top cleats. Two 16" lengths of manila rope are securely attached to opposite sides of the box and serve as carrying handles. The box is stained a light brown, and all the exposed metal parts are painted with light-brown lusterless enamel. The box has identifying marking (see fig. 15) in black paint.

(2) The 20 loaded containers are inserted in the compartments (formed in the box by fiberboard dividers) so that adjacent containers are tail end up and nose end up, respectively.

18 SAFETY PRECAUTIONS

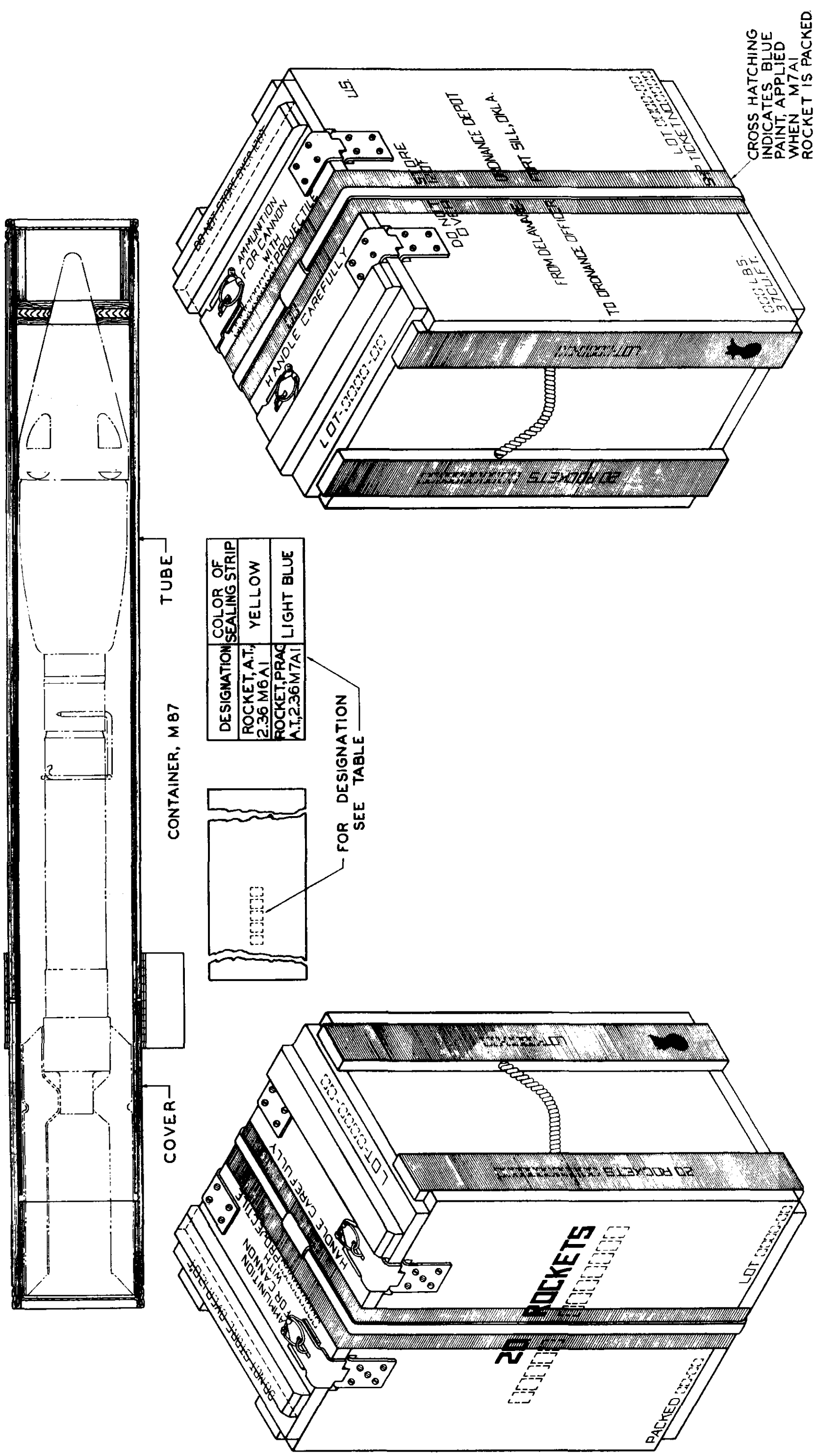
a. The safety pin should be removed only after the nose of the rocket is placed in the launcher.

b. The rocket is sensitive and will function if dropped on its nose upon a hard surface from a height of 4'. Do not remove the safety pin except as explained above. Even when still in the packing containers the rockets must not be subjected to rough handling.

c. Rockets which have been unpacked but not fired should be returned to their original packing containers. The safety pin and the nozzle disk must be in place. The fiber container should be resealed with the adhesive tape.

d. Rockets should be stored in a dry, cool place. They should not be stored where temperatures exceed 120° F., and they should not be exposed to the direct rays of the sun.

e. Face guard and gloves must be worn when the rocket is fired.



DESIGNATION	COLOR OF SEALING STRIP
ROCKET, A.T., 2.36 M6A1	YELLOW
ROCKET, PRAC A.T., 2.36 M7A1	LIGHT BLUE

FIGURE 15. - PACKING FOR THE ROCKET, H.E., AT, 2.36", M6A1

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SECTION II

ROCKET, PRACTICE, 2.36", M7A1

19 GENERAL

The M7A1 rocket (see fig. 15) is similar in design and construction to the M6A1 rocket, lacking only an explosive charge. It has the same dimensions, weight, and trajectory as the H.E. rocket. It is fired in the same ranges as the M6A1 without the cost or danger incidental to firing the H.E. round.

a. Weight rod.— A steel rod, 5.33" long, 0.75" in diameter, and threaded at one end, is fitted into the fuze body. This rod makes up for the weight of the explosive charge and fuze present in the M6A1 rocket. All other components of the M7A1 practice round are similar to the components of the M6A1 rocket.

b. Use.— After it has been fired, the practice rocket, M7A1, may be used again as a dummy round in teaching methods of loading and handling.

c. Painting and marking.

(1) Painting.— All external surfaces of the M7A1 practice rocket, are coated with blue lacquer enamel. Fin surfaces serving as contact points for the igniter system are left unpainted and are tinned with solder.

(2) Marking.— In the same position as on the M6A1 H.E. rocket, the nomenclature of the round, the lot number, and month and year of manufacture appear in white marking ink.

d. Packing.— (1) The practice rocket is packed in the same manner and in the same container as the M6A1 rocket (see par. 17). The sealing strip for the container is light blue, and the appropriate nomenclature is stenciled in white.

(2) Twenty containers are packed into the wooden packing box in the same manner as the H.E. M6A1 round. The packing box is identical but is marked to correspond with the contents. In addition, a 3" blue band encircles the box when the contents are practice rockets. Blue paint is also applied to the vertical cleats at each end of the box.

e. Precautions.— The same precautions described in paragraph 18 must be exercised in the storage and handling of the practice rocket. However, since there is no bursting charge or firing mechanism, the removal of the safety pin does not arm the M7A1 rocket.

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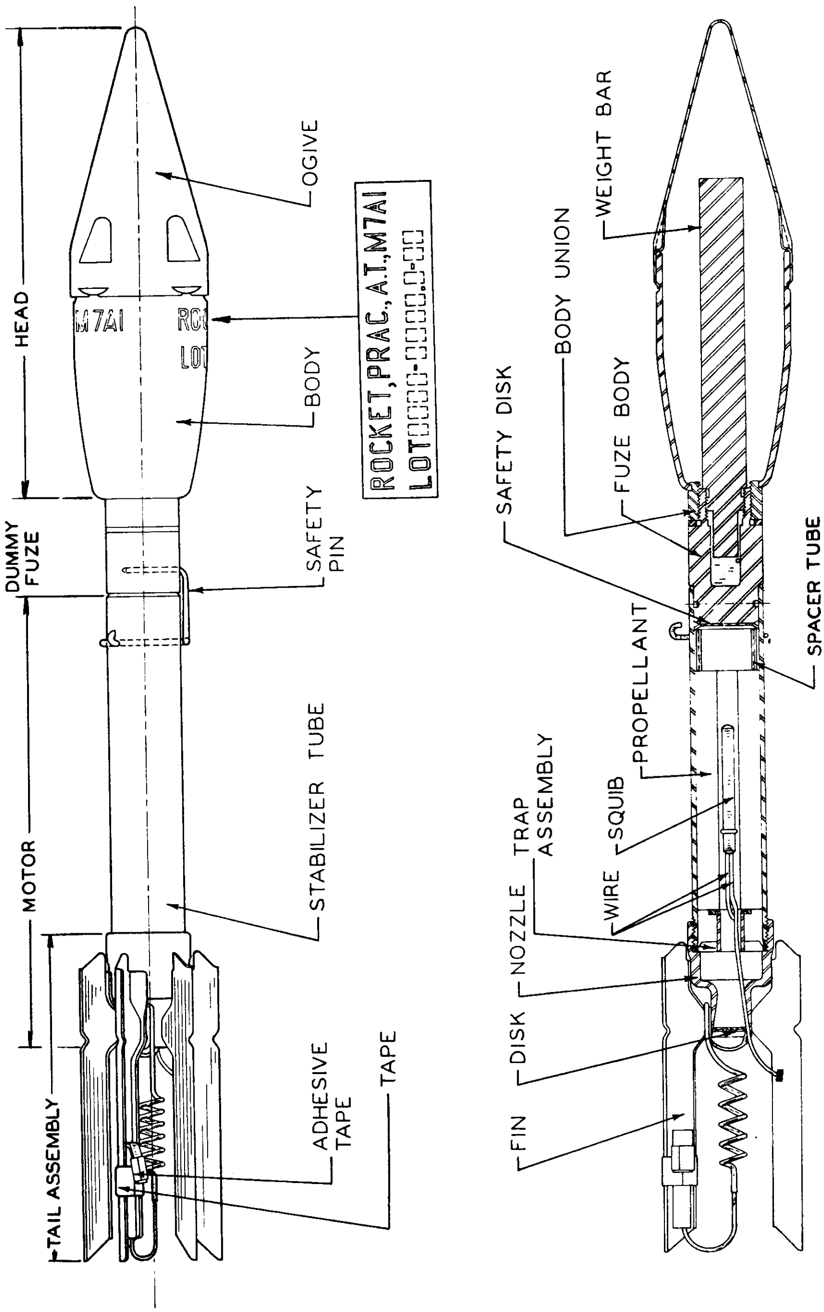

FIGURE 16. - ROCKET, PRACTICE, 2.36", M7A1

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SECTION III

ROCKET, H.E., AT, 2.36", M6A3

20 REASONS FOR CHANGE

a. Change in ogive.— The design of the conical ogive of the M6A1 rocket proved to be undesirable for several reasons. First, the ogive tended to telescope on impact. This resulted in poor transmission of the impact force to the fuze, allowing a variation in the time interval between impact of the rocket and functioning of the fuze in successively fired rockets. Secondly, on impact at angles of 20° or more the conical ogive tended to shear off at the joint of ogive and body. This shearing had a serious effect on penetration of the target. The major difficulty with the conical ogive was that it failed to provide for a uniform, satisfactory penetration of the target by all rockets.

b. Change in tail assembly With the contemplated addition of a hemispherical ogive it was realized that the center of pressure of the rocket would be moved forward and that the rocket would have a definite wobble through its trajectory unless the tail assembly were improved. For this reason it was decided to redesign the tail assembly. A circular assembly was the design finally accepted.

c. Redesignation of model number.— The North African theater has renovated the M6A1 and M7A1 rockets and assigned the model number M6A2 to the renovated rounds. Although the Ordnance Department did not officially recognize this designation, it was felt that the M6A2 designation should not be applied to any new ammunition because of possible confusion and misunderstanding. For this reason the designation M6A3 and M7A3 (see section IV) have been applied.

21 HEMISPHERICAL OGIVE

a. Description.— The ogive, made of sheet steel, has the shape illustrated in figure 17. It is 4-9/16" long and 2.245" in diameter at the flange. The hemisphere is curved on a 1" radius.

b. Effectiveness.— With the hemispherical ogive, the fuze of the rocket has been found to function in an average of 875 microseconds compared to an average of 1250 microseconds in the M6A1 with a conical ogive. Penetration has been uniformly improved. The improvements in functioning and penetration are due to the even transmission of impact force through the straight sides of the hemispherical ogive. On angle impacts, the M6A3 has resisted shearing and has maintained a fast fuze action and uniformly high penetration.

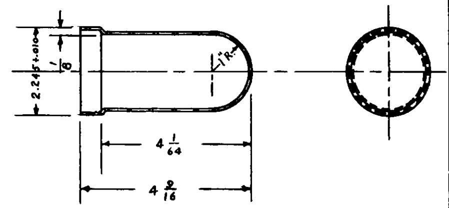


FIG. 17 OGIVE

22 TAIL ASSEMBLY

a. Description of fin.— The new type of fin used on the M6A3 rocket has the shape illustrated in figure 18. Each of the four fins required in the complete assembly is made of .025" sheet steel. The broad blade of the fin is 2-5/16" long and curved over an arc of 90°.

b. Assembly.— Each fin is joined to the other by welding with an overlap

of approximately 1/2". The bases of the fins are spot welded to the nozzle. Through the upright section of one of the four fins is a small hole. This hole is for insertion of one of the ignition wires. In the blade of each fin is a transverse groove which is continuous with the grooves in the other three fins in the complete assembly. This groove is tinned and serves as a contact point with the electrical system of the launcher.

c. Effectiveness.— The M6A3 rocket with the circular fin has slightly better ballistic qualities than the M6A1 rocket had with the old-style tail assembly. Considering that the center of pressure has been moved forward, this is a marked improvement.

23 OTHER CHANGES

There are no other changes in the M6A3 rocket. In all other respects it is similar to the M6A1 rocket.

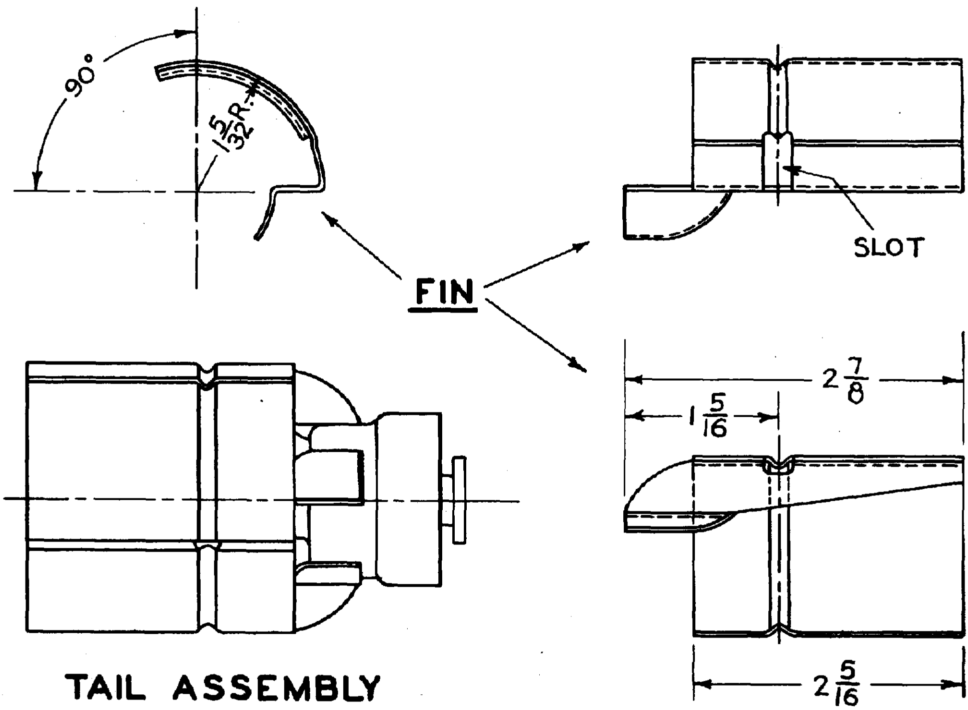


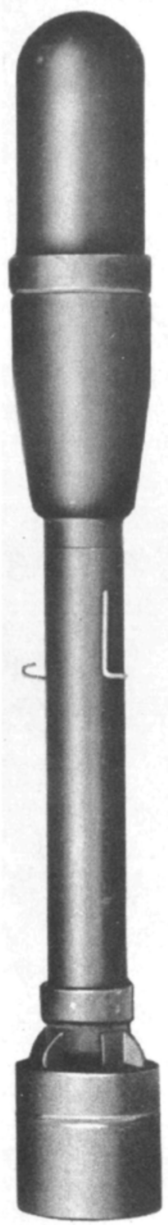
FIG.-18 TAIL ASSEMBLY

SECTION IV

[redacted] **ROCKET, PRACTICE, 2.36", M7A3**

24 CHANGES

The M7A3 rocket has all the changes mentioned above in the M6A3 rocket. It is the practice counterpart of the M6A3 and has the same ballistic qualities.



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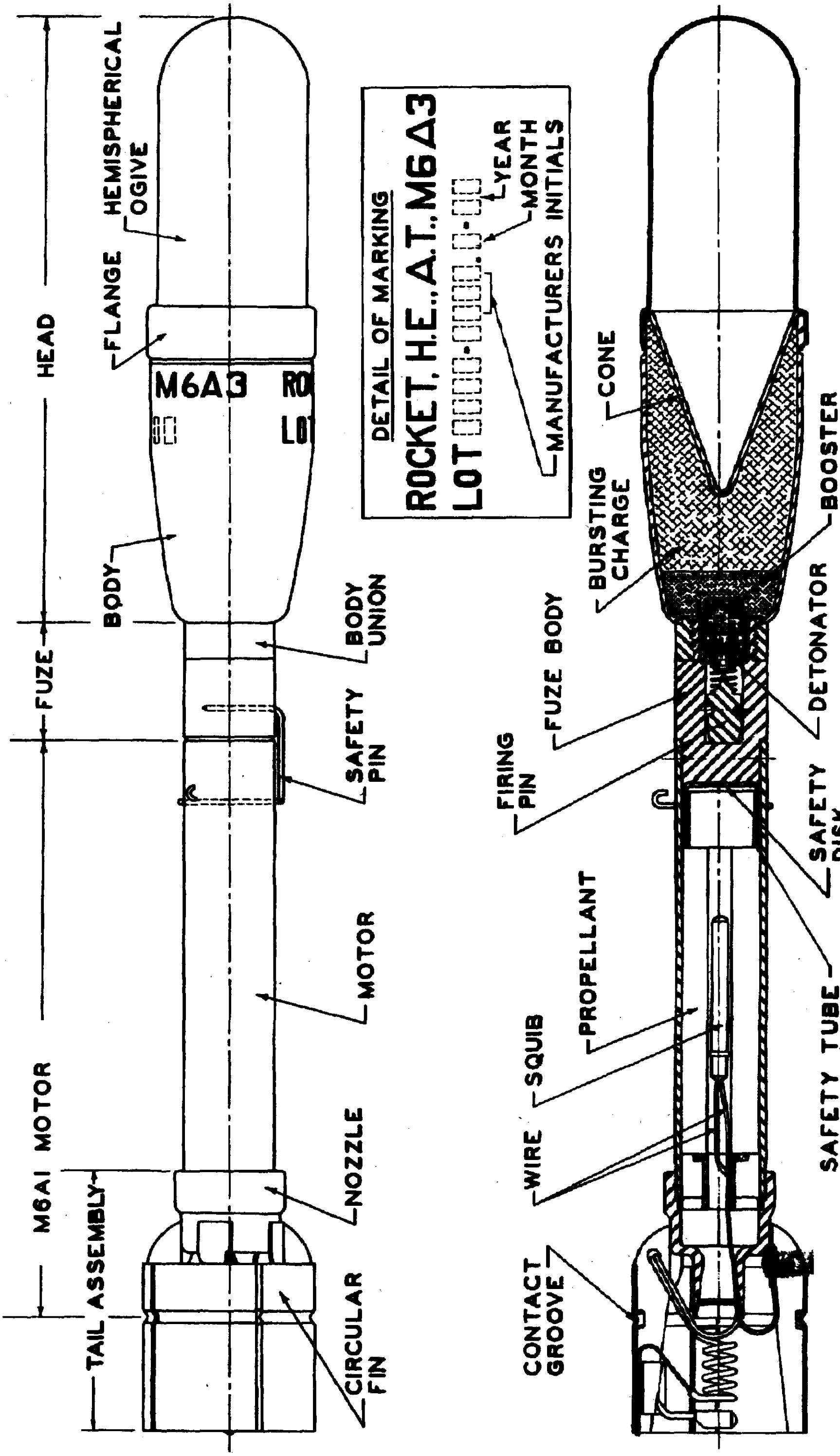

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FIGURE 19. - ROCKET, H.E., AT, 2.36", M6A3

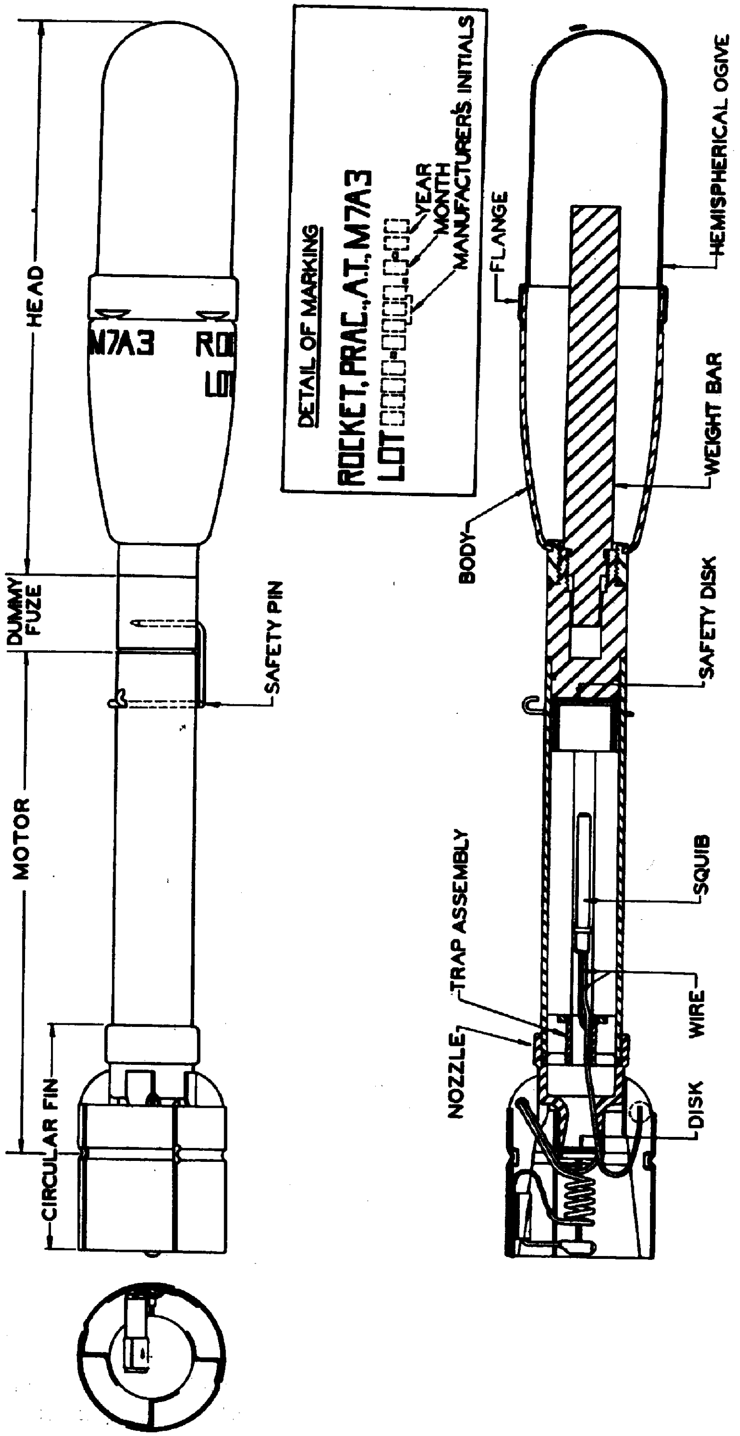

FIGURE 20. - ROCKET, PRACTICE, 2.36", M7A3

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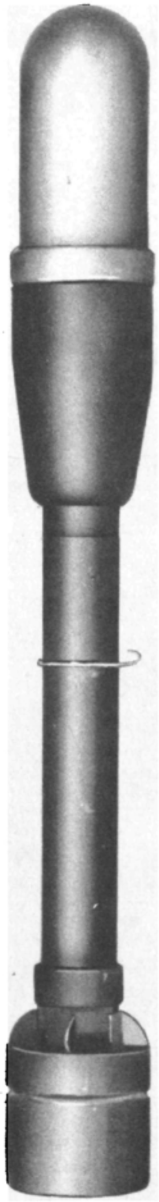

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SECTION V

ROCKET, H.E., AT, 2.36", T12

25 R[illegible]SON FOR DEVELOPMENT

The M6A1 rocket has been used widely in combat, and its deficiencies have been noted. The development work on the T12 was started so that all the deficiencies of the earlier rockets might be corrected. The T12 rocket retains all the good qualities of the M6A3. Specifically, the new performance characteristics are:

a. Greater stability in flight and a consequent greater accuracy.

b. Safe operation through a greater temperature range.

c. A bore-safe fuze — the most important change in the T12.

d. Detonation of the rocket on ground impact for use against personnel. This involves the employment of a more sensitive fuze.

26 GENERAL

a. Appearance.— See figure 21.

b. General data.—

Length, over-all	17.16" max.
Length of head	8-1/4"
Length of motor	7.5"
Length of fin	3-15/16"
Explosive charge	220 gm.
50-50 cast pentolite	214 gm.
10-90 cast pentolite	6 gm.
Propellant (approx.)	63 gm.
Weight of complete rocket	3.72 lb.

c. Components.— The M6A3 head and the T12 head are identical. Several other components, including the fuze, are new. The fuze will be discussed in a separate paragraph; the components of the new motor and fin assembly will be discussed in the following subparagraphs.

(1) Motor assembly.— (a) Tail. The tail is a seamless steel tube 7.50" long and approximately 1.330" in diameter. The rear end of the tube is curved in a venturi. The throat at its narrowest point is .433" in diameter. The central internal portion of the tail is approximately 1.06" in diameter. The forward internal .75" of the tail is threaded. The outer rear surface of the tail seats the tail assembly.

(b) Rein ring.— This circular steel band is shrunk onto the tail at the threaded forward end. It strengthens this end of the tail.

(c) Trap and trap-base assembly.— The trap and trap-base assembly consists of the trap and trap base. The trap is a star-shaped device made of steel. The central portion has a .125" hole, and from it radiate five spokes, 72° apart and .51" long. The trap is fitted onto the trap base. The trap base is a disk 1.0" in diameter and .06" thick. A spindle 21/32" high and .271" in diameter projects from the center of one face. The last 7/32" of the spindle is reduced in diameter to .123". Onto this section of the spindle is fitted the trap. The end is peened to hold the trap in place. The complete trap and trap-base assembly is soldered to the surface of the fuze body. The propellant hangs on the trap and is thus rigidly held in the motor.

(d) Igniter.— No information on this item is available at present.

(e) Propellant.— The propellant in the T12 motor is the same as that used in the M6A3. It consists of five sticks of ballistite, each approximately 4.15" long and .375" in over-all di-

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T12 ROCKET T12 ROCKET

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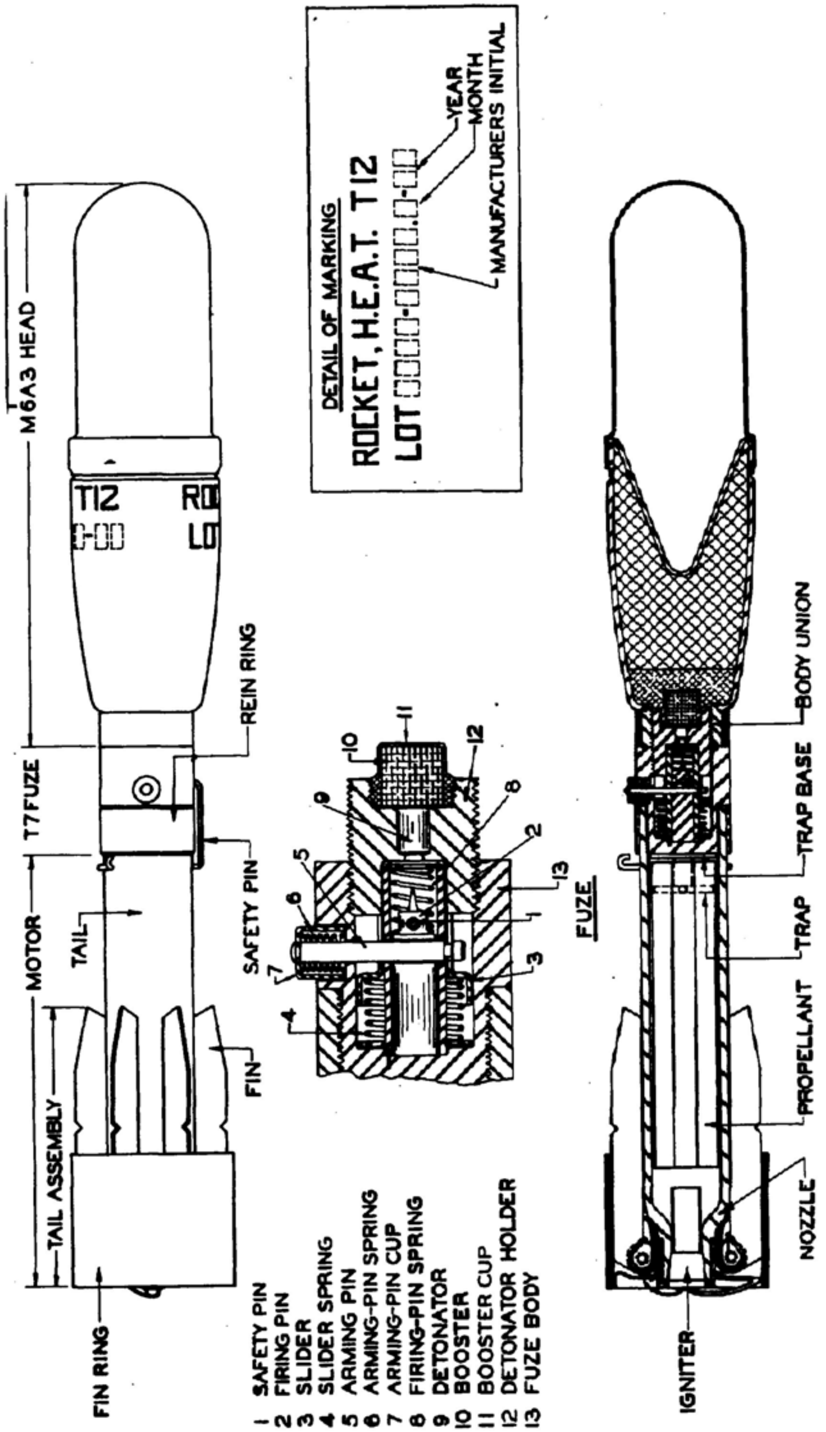
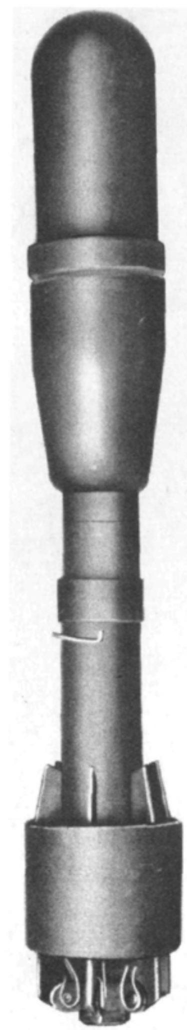


FIGURE 21. - ROCKET, H.E., AT, 2.36", T12



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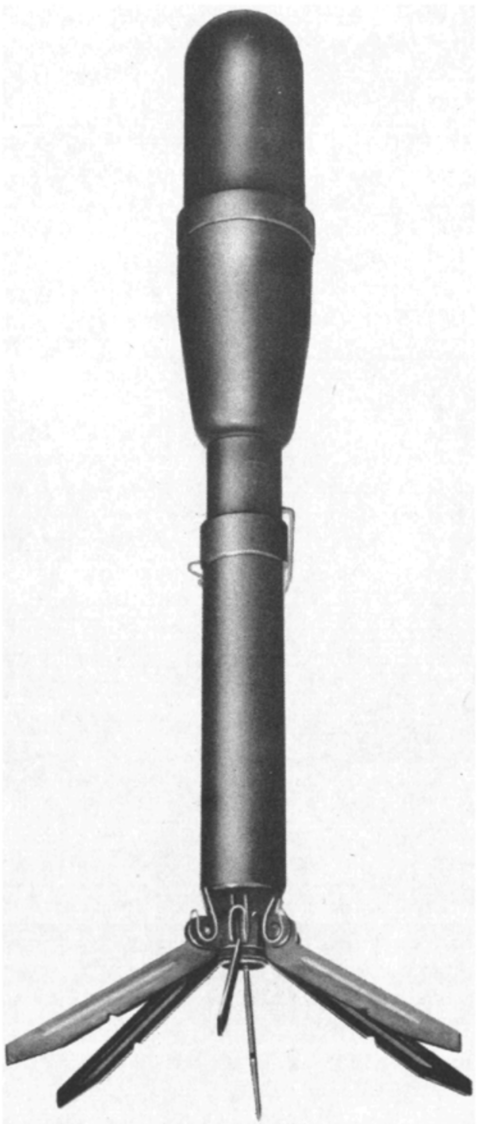

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ameter. Through each stick runs an axial hole .125" in diameter. The rocket is not loaded by weight, as is explained in paragraph 15, but it weighs approximately 63 gm.

(2) Fin assembly.— This assembly consists of six fins, six fin brackets (one of which is slightly different from the other five), rivets, and a fin ring. The six brackets are spot welded onto the tail surface of the motor. The fins are held in place between the brackets by rivets passing through the holes in the brackets and the fin hole. The fin is free to rotate 120° and is checked from further movement by a slanted surface on the back of the fin. The fins are held in place along the motor by a fin ring. This ring is a circular band and is removed when the rocket is placed in the launcher.

27 FUZE, ROCKET, 2.36", T7

a. General.— The T7 fuze was developed to meet the need for a safer, faster functioning fuze. (See fig. 21.) Shortly to be standardized, it will be used in the T12 and the T23 rockets. The major difference between the T7 fuze and the fuze used in the M6A1 rocket is that the T7 is of the "bore-riding" pin type similar to the M52 mortar fuze. Because of this bore-riding feature, the T7 fuze is bore safe and yet suffers no reduction in effectiveness.

b. Action.— (1) The safety pin passing through the firing pin holds the latter securely in place. The slider spring presses forward against the shoulder of the slider. The slider, which is slotted on its forward rim, hooks into a groove in the inner end of the arming pin, holding the arming pin in position.

(2) When the safety pin is withdrawn, the firing pin is still held securely in place by the arming pin. Upon set-back, however, the slider is forced to the rear against the tension of the slider spring. This permits the arming pin, disengaged from the slider, to be forced out by the compression of the arming-pin spring until the arming-pin cup strikes the wall of the launcher.

(3) As long as the rocket remains in the launcher, the arming pin is held partly in the firing pin, holding the latter in position.

(4) When the rocket has cleared the launcher, the arming pin with its attached cup and the arming-pin spring are expelled. The firing pin is now free to move. The firing-pin spring is an "anti-creep" factor, preventing the firing pin from contacting the detonator except on impact.

(5) On impact, the firing pin, is driven into the detonator by inertia, exploding it. The detonation passes through the booster, where it is amplified, and the function of the fuze is complete.

c. Explosive components.
(1) Detonator, M18.— This is the same detonator as that assembled with the M6A3 rocket.

(2) Booster.— This is the same booster as that used with the M6A3 rocket.

d. Safety devices.— This fuze has several safety devices, most of which have been mentioned above. They are as follows:

(1) Safety pin.— This component holds the firing pin firmly in place and makes the fuze safe up to the shear point of the safety pin. This shear point will rarely be exceeded.

(2) Slider.— This component, under tension of the slider spring, holds the arming pin in place. The slider may be forced to the rear if sufficient acceleration could be simulated. Even in a free fall of 1' to 2' this acceleration would not be approximated and the slider would stay in its forward position.

(3) Arming pin.— This component makes the fuze bore safe, since it does not permit the firing pin to move forward until the rocket is clear of the launcher and the arming-pin assembly expelled.

(4) Firing-pin spring.— This spring prevents premature detonation of the rocket. Without the spring, the firing pin could move forward by creep action and set off the detonator.

28 BALLISTICS

a. Range.— The rocket has the same range as the M6A3, but its effective range has been slightly increased by the new fin assembly.

b. Penetration.— On angles of impact up to 30° the T12 rocket will penetrate the armor of any known enemy tank.

c. Effective fragmentation radius.— No information available.

d. Muzzle velocity.— No information available.

e. Launcher employed.— The M1A1 and M9 launchers are used to fire this rocket.

29 PAINTING AND MARKING

a. Painting.— All external surfaces of the rocket except the tinned notches of the fins are coated with olive-drab lacquer enamel.

b. Marking.— In two circumferential lines just below the flange on the rocket head is stenciled the following information:

ROCKET, H.E., AT, T12

LOT 0000-0000.00-00

All the figures and letters are 3/8" high and are applied with yellow marking ink. The lot number includes the month and year of manufacture and the initials of the manufacturer.

30 PACKING

One T12 rocket is packed in a fiber container, T1. Twenty loaded containers are packed in a wooden packing box (see fig. 22).

a. Fiber container, T1.— This container is generally similar to all fiber containers. It is 18-3/8" long and 2-15/16" in diameter. The cover fits over the inner wall of the body and is held in place by a strip of yellow adhesive tape. The yellow sealing strip is 2" x 20-3/4" and is marked with 1/4" black characters as follows:

ROCKET, AT, 2.36", T12

The rocket is inserted in the container, ogive first, coming to rest on a ring-shaped plywood support in the bottom of the tube.

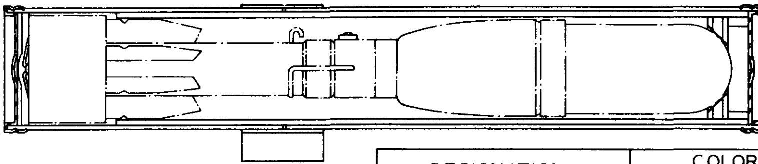
b. Packing box.— The packing box is generally similar to the packing box for the M6A1 rocket. The lid of the box is hinged on the side, and there is a single hinge and hasp. This box differs from the box for the M6A1 by the addition of stenciled Ammunition Identification Code designation. The volume of the new box has been reduced to 3.25 cu. ft.

Packing-box data

No. of rounds contained	20
Volume	3.25 cu. ft.
Total weight	
Dimensions	20-1/8" x 19-1/8" x 14"
No. of carrying handles	2

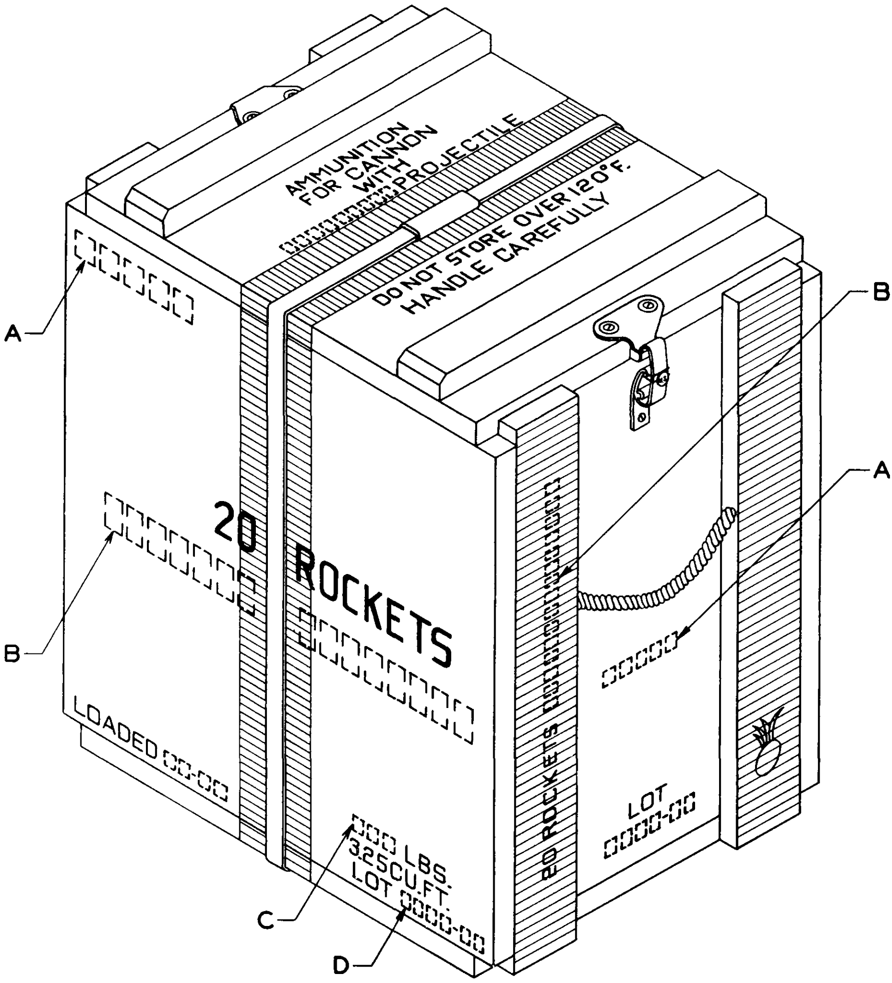
31 SAFETY PRECAUTIONS

All the safety precautions observed in handling the M6A1 rocket must be followed in handling the T12. In addition, the fuze of the T12 rocket is more sensitive to set-back, and a fall of 2' to 3' will cause the round to explode.



FIBER CONTAINER, T1

DESIGNATION	COLOR OF SEALING STRIP
ROCKET, A.T. 2.36, T12	YELLOW
ROCKET, PRACTICE A.T., 2.36, T23	LIGHT BLUE



A - INSERT A.I.C. CODE.
B - INSERT "H.E., A.T., 2.36 IN., T12" OR "PRACTICE, A.T., 2.36 IN., T23" AS APPLICABLE.
C - INSERT GROSS WEIGHT.
D - INSERT LOT NUMBER.

FIGURE 22. - PACKING OF THE T12 AND T23 ROCKETS - [redacted]

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